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by

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FOREWORD

The following paper on "Moisture and other quality factors of copra," by Dr. W.R.N. Nathanael, now Acting Director, Coconut Research Institute of Ceylon, was first presented at the Second Session of the Working Party on Copra Quality and Grading of the FAO Group on Coconut and Coconut Products, held in Colombo in August, 1959.

Since the paper contains research material not available elsewhere, it is now distributed under the Technical Information Service of the FAO Regional Coconut Improvement Project, in consultation with Mr. J. Stopforth, Acting Chief, Fats and Oils Section, Commodities Division, FAO, Rome.

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MOISTURE AND OTHER QUALITY FACTORS OF COPRA

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INTRODUCTION

In no department of analytical chemistry is greater difficulty experienced than in that which deals with the examination of natural food products. Of these food products perhaps none presents so much diversity in natural composition as do the oils, fats and fatty foods. This diversity of character combined with difficulty of resolution has made the examination of oils, fats and fatty foods both prolific of method and uncertain in result. Added to this, it should be pointed out that major difficulties are sometimes encountered in obtaining proper representative samples of the material for analysis. Each different substance has to be carefully considered and quite as much thought given to every stage of sampling as to the analysis. An obviously unrepresentative sample, carelessly taken and analysed, is useless. In fact, nothing can be more absurd than for an analyst to apply all the skill and delicacy of careful analytical tests to a sample which does not represent the bulk of material of which it is required to know the composition.

Copra is essentially a food commodity and the entire subject of its inspection and analysis has assumed considerable importance in recent years. Based principally on studies carried out at the Coconut Research Institute (Ceylon), it is proposed to bring within the compass of this paper as much available information as possible bearing on the different facets of the subject of copra quality. Before doing so, it is felt that a few facts about copra and its characteristics may be reviewed to advantage, in order to afford a better understanding of the subject as a whole.

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* Paper presented at the Second Session of the Working Party on Copra Quality and Grading of the FAO Group on Coconut and Coconut Products (Colombo, August 1959).

CHANGES DURING DEVELOPMENT OF THE COCONUT

In the strict botanical sense the coconut is a drupe and not a nut. If we consider its development and floral biology it should be possible to identify at least 25 distinct stages from the time the rudimentary inflorescence makes its appearance until the cluster of fully ripe nuts is ready for harvesting.

The kernel first makes its appearance as a jelly like substance at stage 20 in the series.* This would correspond to an age of about 6 months from the time the inflorescence sheath bursts and the flowers are exposed. At stage 25 the kernel is fully formed and mature and is best suited for the preparation of quality copra. The age of the ripe drupe corresponding to stage 25 would be about 12-13 months from the time of opening of the inflorescence.

I have given in Table I below the average oil and moisture contents in the kernel during the course of its progressive development between stages 20 and 25. Parallel data are also given showing the total wet and dry weights of kernel per drupe. These changes are illustrated graphically in Figure I.

Table I

Changes in the Moisture and Oil Contents of the Coconut Kernel during Progressive Stages of Development

1	2	3		4		5
Stage	% Total Moisture in kernel	Weight of kernel per Nut (grammes) WET	DRY	% OIL Wet basis	Dry basis	Description
1-19	NO	KERNEL				No Pulp
20	94.6	22	1.2	0.9	16.0	Very tender Kurumba
21	83.9	111	16.9	7.7	47.5	Tender Kurumba
22	74.3	165	42.2	14.8	57.3	Kurumba
23	65.2	216	75.0	23.2	66.6	Tender Kalati
24	49.0	260	132.0	36.1	70.7	Kalati
25	42.5	273	161.4	41.7	68.1	Ripe Green Nut

* The original paper was supported by drawings illustrating the twenty-five stages of development of the nut. The drawings are not available for reproduction.

The results reveal the following interesting features :-

(a) That the moisture content steadily drops from about 95 per cent in the very tender gelatinous kernel to about 43 per cent in the ripe fruit.

(b) That the oil content (dry basis) unlike the moisture increases with the ripening of the fruit. The figures recorded show an increase from 23 per cent to 68 per cent. The high value (70.7%) obtained in this study for stage 24 appears to be unusual. It is proposed to repeat the study to check this point.

(c) That there is a progressive increase in the deposition of dry matter in the kernel - the results showing an increase from 1 gramme to 161 grammes between stages 20 and 25.

Having made the observation that the moisture content of the mature kernel is of the order of 43 per cent, it might be useful to consider whether any fluctuations or wide deviations from this figure do occur on storage of picked nuts in the open (seasoning) prior to processing. Analytical data relevant to this subject are charted in Table II below. For each category of nuts in the experiment 250 were taken and these were sampled and analysed for moisture content in ten lots of 25 each.

It will be seen from the results presented in the table that the following average figures represent the moisture content in the different categories examined :-

Category	Average Moisture Content (per cent)	Range (per cent)
Fallen Nuts	43.5	42.0 to 44.4
Ripe Green Nuts (Fresh)	43.8	43.2 to 44.5
Ripe Green Nuts (15 days seasoning)	43.6	42.6 to 44.5
Ripe Green Nuts (30 days seasoning)	44.2	42.5 to 45.9
Overall average	43.8	42.0 to 45.9

On the basis of the present studies the general conclusion may be drawn that though the moisture content in the kernel varies widely with the maturity of the drupe itself, yet it does not significantly alter in the mature kernel during storage or seasoning. The overall average of 43.8 % moisture (ranging between 42.0 to 45.9) may be adopted as a reliable figure for all practical purposes.

Table II

Moisture Content of the Coconut Endosperm

1	2	3		
Sample	FALLEN NUTS (Dead ripe nuts naturally falling from the palm)	PICKED RIPE GREEN NUTS		
		Immediately on harvesting	After 15 days seasoning on the field	After 30 days seasoning on the field
1	43.93	44.44	43.99	45.92
2	41.98	44.48	43.34	44.98
3	42.91	43.50	44.00	45.76
4	43.87	44.54	42.55	44.58
5	43.48	43.66	43.80	43.58
6	43.22	43.18	43.46	44.88
7	43.52	43.74	44.51	43.74
8	43.62	43.88	44.11	42.70
9	44.38	43.17	43.50	42.50
10	43.62	43.65	43.04	43.73
MEAN	43.45	43.82	43.63	44.24
RANGE	41.98 to 44.38	43.17 to 44.54	42.55 to 44.51	42.50 to 45.92
S.D.	0.6532	0.5096	0.5720	1.1812
C.V.(%)	1.50	1.16	1.31	2.67
S.E.	0.21	0.16	0.18	0.37

S.D. = Standard Deviation.

C.V. = Coefficient of Variation.

S.E. = Standard Error.

CHANGES DURING GERMINATION OF THE COCONUT

Having discussed the changes that take place in the kernel during the development of the coconut it might be appropriate at this stage to consider the changes in moisture and oil content of the kernel during the progress of germination itself. The observations on these changes are reckoned to be of some significance since certain commercial grades of copra invariably include the kernel from germinated coconuts. Further, these observed changes would also have a bearing on the subject of quality standards.

The analytical data reviewed in Table III represent the changes that take place in the kernel during the progress of germination up to a period of 7½ months from planting of nuts in nurseries.

The distinctive features of the results may be summarised as follows :-

(a) There is a decided tendency for a drop in the moisture content of the kernel during germination. This becomes particularly marked after 20 weeks from planting, from which stage onwards there is a steady fall in moisture from 41.9 per cent to 33.4 per cent.

(b) Unlike moisture, the tendency for changes in the oil content is definitely in the reverse direction. It will be seen that after 20 weeks this becomes very marked - the oil percentage steadily rising from 72.9% to 76.7% (dry basis).

(c) Regarding the question of actual oil recoveries per nut it will be seen from column 4, that there is a persistent drop after 18 weeks from 133.8 grammes to 110.4 grammes.

(d) Though the oil contents are high when expressed as a percentage, it will be seen that these high values actually correspond to lower recoveries of oil per nut. The inference can, therefore, be drawn that from the commercial point of view, on a weight basis the low grade copra prepared from well germinated coconuts will yield more oil on expression. Though this will be of value to the oil miller, yet it should be remembered that the quality of oil and also the poonac (meal) recovered is inferior and should cause refinement losses. From the point of view of production economics, however, there is no advantage in preparing copra from germinated coconuts because the quantity of oil recovered per nut is below average. That this is so will be evident when we consider the fact that the average oil recovery per nut during the first 18 weeks of planting is 136 grammes and for the period 20-30 weeks is only 122 grammes. (Computed from Table III, Column 4).

It will be useful at this stage to attempt an explanation of the foregoing observations made on the changes that take place in the kernel during germination.

Table III

Changes in the Moisture and Oil Content of the Coconut Endosperm during Germination

1	2	3		4	5	
Number of weeks in Nursery	% Total Moisture in Kernel	Weight of Kernel/Nut (Grammes)		Weight of Oil/Nut (Grammes)	%Oil	
		Wet	Dry		Wet Basis	Dry basis
nil	43.7	345	194	133.3	38.7	68.7
2	43.2	346	197	134.2	38.7	68.1
4	45.1	351	193	131.8	37.5	68.3
6	43.3	339	192	134.4	39.7	70.0
8	42.1	350	203	139.9	39.9	68.9
10	42.3	343	198	138.8	40.4	70.1
12	42.9	344	196	135.8	39.6	69.3
14	42.6	346	199	139.3	40.2	70.0
16	42.2	336	194	137.0	40.8	70.6
18	41.5	324	190	133.8	41.2	70.4
20	41.9	303	176	128.3	42.4	72.9
22	40.1	289	173	127.7	44.2	73.8
24	40.0	281	169	124.9	44.3	73.9
26	39.2	271	165	123.6	45.5	74.9
28	37.5	242	151	115.1	47.6	76.2
30 (7.5 months)	33.4	216	144	110.4	51.1	76.7

The figures presented in Table IV demonstrate conclusively that there are to be found in the coconut kernel definite oil and moisture gradients when sliced tangentially, parallel to the testa or brown integument.

Table IV

Oil and Moisture Gradients in the Coconut Endosperm

1	2	3	4
REGION	% MOISTURE	% OIL(wet basis)	% OIL(Dry basis)
T	29.1	44.2	62.4
RT	32.9	50.6	75.4
IR	44.1	37.9	67.8
RW	59.3	22.9	56.3

T = Testa IR = Intermediate region

RT = Region near testa RW = Region near water cavity.

For the experiment, the fresh kernels from ungerminated coconuts alone were used. These were split into half cups in the usual way and 1/8" radial strips were taken from each cup by making longitudinal cuts. Each of these strips was then sliced parallel to the testa so that besides the parings three sections of equal thickness were obtained from the white meat. The corresponding sections from each strip were then bulked and analysed for moisture and oil content.

The results show that the section least rich in oil (56.3%) is on the inside, nearest the water cavity. The section richest in oil (75.4%) is nearest the testa, and the intermediate section fits in between with an oil content of 67.8%. The testa itself contains 62.4% oil. It will be seen that the moisture gradient is in the reverse direction.

With a knowledge of these facts it is easy to understand the changes that have been observed to take place in the kernel during germination. In germination it would appear that the inside tissues least rich in oil progressively break down as the haustorium (or apple) develops leaving the layers which are richer in oil. That this is so will be seen from the fact that the oil content of 76.7% recorded for the very thin kernel wafer from nuts that have been in the nursery for 7½ months is not far different from 75.4%, the oil content registered for the region of the kernel nearest the testa.

The explanation for the drop in moisture content of the kernel with the progress of germination is similarly provided by the fact that the tissues on the inside which break down first are richer in moisture (59.3%) than the residual layers nearer the testa (29.1%).

CHARACTERISTICS OF CEYLON ESTATE COPRA

Published literature contains recorded oil percentages for copra from various producing countries. These figures have been found to be very variable, ranging between 57 to 75 per cent. The sources of these figures vary in reliability and in many cases may not be regarded as truly representative. It is felt that the very high figures have been recorded on deteriorated low grade samples of copra where due to mould action the inside layers of the kernel have been destroyed. The unusually low figures have probably been recorded for copra derived from immature nuts. It can be said, however, that apart from such causes definite variations do seem to occur, but no definite conclusions can be drawn from the available data.

Without doubt, Ceylon copra could be considered superior to that produced in most other countries. In general practice, copra produced on estates in this country is sorted into three grades which are categorised as numbers 1, 2 & 3. It will be informative at this stage to consider the general quality and analytical characteristics of these 3 grades.

With the object of obtaining information of a positive and reliable nature, samples of Nos. 1, 2 & 3 copra from seven estates in different parts of the island were drawn at regular intervals and a comprehensive set of analytical determinations carried out. The situations of the seven estates were as follows : two in the Western Province (Mirigama and Kalutara districts) three in the North Western Province (Puttalam, Chilaw and Kurunegala districts) and one each in the Eastern and Southern Provinces. The results obtained in these studies are summarised in Tables V to VIII.

Before we proceed to consider the results, it should be useful to make some reference to the manner in which copra is sorted and graded on estates. As a rule, what is classed No. 1 copra would include half kernels from mature, well seasoned and ungerminated nuts that are well dried, of good colour and free from dirt, stains and burn marks. The halves would also generally be of good shape and appearance. From the bulk of copra from the kiln, after drying is completed, such No. 1 copra is first sorted out. The remainder is usually given a further firing after which a little more No. 1 may be separated and the remainder is sorted into No. 2 and No. 3 grades.

No. 2 copra would be as well dried as No. 1, but may be somewhat discoloured by smoke and other stains. It will generally include halves from somewhat immature nuts or slightly germinated nuts. Into No. 3 grade

Table V

Analyses of No. 1 Estate Copra

1	2	3	4			5			6			7		
No. of Estate	Province	No. of Samples	% Moisture			% Oil(Wet Weight)			% Oil(Dry Weight)			% Oil Average values for:		
			Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Iodine Value	Saponification value	F.f.a. (extracted oil)
1	W.P.	6	7.4	5.1	6.5	65.5	62.8	64.1	69.2	67.8	68.5	8.2	258.6	0.07
2	E.P.	6	7.4	5.8	6.8	64.8	63.2	63.9	69.5	67.9	68.6	8.0	256.8	0.07
3	N.W.P.	6	8.9	7.4	8.2	63.8	61.3	62.3	69.0	66.5	67.8	8.2	256.9	0.06
4	W.P.	12	8.1	5.6	7.1	65.0	61.7	63.0	69.1	66.5	67.8	8.2	259.4	0.06
5	N.W.P.	6	6.8	6.0	6.4	65.0	63.1	64.3	69.3	67.5	68.6	8.0	259.8	0.05
6	S.P.	6	7.9	5.6	6.4	65.4	63.4	64.4	69.7	68.1	68.8	8.3	261.1	0.05
7	N.W.P.	6	7.2	5.2	6.1	65.3	62.9	64.3	69.0	67.6	68.5	8.2	260.4	0.05
Miscellaneous		4	7.9	4.5	6.3	65.3	62.0	63.9	69.2	66.7	68.2	8.0	258.9	0.15
Total		52	8.9	4.5	6.8	65.5	61.3	63.7	69.7	66.5	68.3	8.16	259.1	0.06

Note :- Under Miscellaneous are included 4 samples as follows : 2 random samples from estates not included in the original seven and 2 samples taken from bulk in Colombo stores.

Table VI

Analyses of No. 2 Estate Copra

1	2	3	4			5			6			7			8		
No. of Estate	Province	No. of Samples	% Moisture			% Oil (Wet Weight)			% Oil (Dry Weight)			Free Fatty Acid (extracted oil)			Free Fatty Acid (Pressed oil)		
			Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
3	N.W.P.	6	8.2	4.2	6.3	68.1	63.6	65.7	71.1	69.0	70.2	0.66	0.04	0.22	0.86	0.04	0.32
5	N.W.P.	6	8.1	4.3	6.1	68.9	62.5	66.1	72.6	67.7	70.3	0.40	0.06	0.16	0.40	0.04	0.22
6	S.P.	6	6.9	5.2	6.0	67.7	65.2	67.0	72.5	70.0	71.1	0.52	0.02	0.22	1.76	0.04	0.49
7	N.W.P.	6	8.5	5.2	6.9	66.7	63.4	64.7	70.4	68.9	69.5	0.23	0.04	0.18	0.58	0.04	0.22
Total		24	8.5	4.2	6.4	68.9	62.5	65.9	72.6	67.7	70.3	0.66	0.02	0.20	1.76	0.04	0.31

Table VII

Analyses of No. 3 Estate Copra

1	2	3	4			5			6			7			8		
No. of Estate	Province	No. of Samples	% Moisture			% Oil (Wet Weight)			% Oil (Dry Weight			Free Fatty Acid (extracted oil)			Free Fatty Acid (Pressed oil)		
			Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
3	N.W.P.	6	8.9	4.3	6.6	67.5	61.9	63.9	70.5	66.7	68.5	0.95	0.12	0.39	0.97	0.28	0.55
5	N.W.P.	6	7.4	4.0	6.2	66.4	61.7	64.5	70.6	66.2	68.8	0.65	0.18	0.41	1.05	0.15	0.65
6	S.P.	6	7.1	4.8	6.0	69.2	64.7	67.1	72.7	69.3	71.4	0.57	0.19	0.39	1.33	0.24	0.76
7	N.W.P.	6	9.4	5.4	7.1	66.4	61.7	63.4	70.2	66.2	68.2	0.39	0.08	0.28	1.17	0.18	0.46
Total		24	9.4	4.0	6.5	69.2	61.7	64.7	72.3	66.2	69.2	0.95	0.08	0.37	1.33	0.18	0.60

go badly discoloured halves, soft leathery halves from very immature nuts, and thin halves, with shrivelled surfaces, derived from germinated nuts. The very black charred and decaying pieces, which are sometimes mixed with No. 3 copra, should in proper estate practice be classed separately as "refuse copra".

Apart from the efficiency of the kiln and the skill of the processors, factors influencing the proportion of the inferior grades are droughts, which lead to immature nut-fall, wet weather during drying, and delay in drying, leading to increased germinations. As there appears to be considerable variation in estate sorting practice, the percentage distribution of Nos. 1, 2 and 3 would also doubtless be contingent on the particular grading system employed. The overall average sorting figures typical for the whole year on Bandirippuwa Estate (Coconut Research Institute of Ceylon) have been found to be : No. 1 Copra 94.5, No. 2, 4.5 and No. 3, 0.7 percent.

Regarding the analytical results for Estate No. 1 copra it may be said at once that no definite variation in the percentage of oil content of the copra with the situation of the estate can be established from these results. Even the maximum difference observed, that between estate Nos. 3 and 6 - Table V, does not appear to be statistically significant. These figures indicate that the value 68.3 % (dry basis) is a reasonably accurate one for the average dry weight oil percentage of No. 1 Ceylon Estate copra. The results summarised in Table VIII give confirmation of this, showing that 38 out of 52 samples (i.e. 73% of the total) fall in the two groups 67-68 and 68-69 per cent. These studies have further revealed that no relation of oil content to the time of year (when nuts are harvested) can be established. The overall average moisture content of the samples examined will be seen to be 6.8 %.

Table VIII

Distribution of Moisture and Oil Contents (No.1 Estate Copra)

% MOISTURE		% OIL (Dry basis)	
Group	No.of Determinations	Group	No.of Determinations
4 to 5 %	1	62-63 %	0
5 to 6 %	11	63-64 %	0
6 to 7 %	21	64-65 %	0
7 to 8 %	14	65-66 %	0
8 to 9 %	5	66-67 %	4
9 to 10 %	0	67-68 %	14
-	-	68-69 %	24
-	-	69-70 %	10
Total	52	Total	52

Regarding the free fatty acid content of the extracted oils from estate No. 1 copra, the analytical figures in Table V, column 7, show that the average is only 0.06 %, indicating that the copra samples as analysed were fresh and undeteriorated. The interesting fact that coconut oil is one of the least variable of the commercial fats is indicated by the little variation shown in the iodine and saponifaction values.

In general it may be said that most Ceylon estate No. 1 copra is satisfactory in all but appearance, which can be improved somewhat by prevention of smoking. There seems little need in most cases to recommend more stringent drying.

With regard to the analytical results on estate copra (Nos. 2 and 3), it is not altogether surprising that the oil percentages of the inferior grades are on the whole higher than that of No. 1 copra. More than one factor may contribute to this. For instance, it has been observed that long continued drying tends to decompose slightly and decrease the weight of the constituents of copra other than oil without affecting the oil itself. The percentage of oil in the finished copra is thus increased. It has already been mentioned that No. 2 and No. 3 copra are usually dried longer than the first selected No. 1. Then, of course, the fact that there is an oil gradient in the kernel (which has been demonstrated) would also tend to give higher oil percentages as the inside tissues are removed by mould or bacterial action.

That, in the present study, the average oil content of No. 3 copra (69.2%) is somewhat lower than that of No. 2 (70.3%) is probably to be explained by the inclusion in this grade of copra from very immature nuts. The slightly immature kernels which go into No. 2 have oil contents not very different from those of ripe nuts, but the oil content of very immature kernels has already been shown to be much less. Any increase in the oil content due to the factors described in the preceding paragraph is thus offset to some degree.

That all the samples of copra received for this study have been well dried will be clear from Tables V to VII. We have already noted an average of 6.8 per cent moisture for 52 samples of No. 1 copra. Tables VI and VII record a range of 4.2 - 8.5 (average 6.4) for 24 samples of No. 2, and a range of 4.0 - 9.5 (average 6.5) for 24 samples of No. 3.

Regarding the free fatty acid content of the extracted oils from the three grades, it has been noted already that for the samples of fresh No. 1 copra very few contained over 0.1 per cent, the average being only 0.06 per cent. The acidities of the oils from No. 2 and No. 3 copra are naturally higher but not unduly so. It will be seen that the averages are 0.20 and 0.37 per cent for the No. 2 and No. 3 grades respectively. It is both significant and interesting that the corresponding figures obtained on samples of the pressed oil are higher, averaging 0.31 and 0.60 per cent respectively for the two grades. It is proposed to revert to this point later in the context of copra sampling.

It is apparent from the results obtained that there can be little objection to the use of No. 2 and No. 3 grades for local milling on the grounds of oil content or quality. Their physical nature should, however, be regarded as an objection, because rubberiness is regarded as a fault which tends to choke machinery and impede efficient pressing. In local practice, however, No. 2 copra, and even No. 3, is bulked in certain proportions with No. 1 for purposes of crushing. The inferior grades are, of course, undesirable for overseas shipment, because they are more liable to deterioration by moulds.

COPRA FROM VARIETIES GROWN IN CEYLON

Apart from the size and maturity of the fruit it is reasonable to expect that the quantity of copra and oil in a coconut would also be influenced to some extent by other factors such as varietal (and genetic) differences, climate (in its widest sense), soil conditions and perhaps fertilizer practice.

The typica or tall coconut palm, which is cultivated on a plantation scale, represents the variety that is grown principally for commercial purposes. Besides this, there are also other varieties and forms which are grown to a limited extent in the island. The economic possibilities of evolving hybrids (with high oil contents in the kernel) by selective breeding is no doubt an interesting speculation and is considered a subject well worth investigation. It is deemed appropriate, therefore, at this stage that any information so far accumulated on the oil content of the different available types should be compared with those that have been established for the tall palm. These figures are reviewed in Table IX below. It should be mentioned that only fresh samples of copra were used in this study so that they were uncomplicated by the changes accompanying deterioration or germination.

It will at once be apparent from the analytical results that the dwarf green (69.9%) - nana variety, Gon thembili (69.2%) - a form of the typica variety - and Bodiri (69.6%) - also a form of the typica variety - are the only ones, if at all, which have given somewhat higher figures than the commercial tall palm for oil content. As variations could be very wide it is proposed to check up on further samples to see whether these three types do in fact give consistently higher figures of significance to warrant botanical investigations.

Regarding the possible effects of climatic and edaphic factors on the oil content of the coconut kernel, there would appear to be some corroborative evidence to support this view. For instance, the average oil percentage (dry weight) for Malayan estate copra (typica variety) found by Georgi (1) is 65.6, whereas in the present studies the corresponding figures found for Ceylon estate copra is 68.3. Cooke (2) quotes analyses of 3 parcels of No. 1 Ceylon copra as follows : (a) 70.13 (b) 68.72, and (c) 68.2 per cent oil (dry weight) and other similar figures are on record. Fritsch (3) quotes for a sample of Ceylon copra 68.6 per cent. Further, an authoritative handbook on oils and fats (4) gives the following average figures :-

Table IX

(Oil content of the varieties and forms of coconut grown in Ceylon)

1	2	3	4		5	6	7	8
Sample	Variety or Form	% Moisture	% OIL		No. of Nuts	Weight of Copra (lbs.)	Out-turn Nuts/ candy	Copra Quality
			Wet basis	Dry basis				
1	Tall palm (variety-TYPICA)	6.8	63.7	68.3	2,600	1133.96	1,284	Uniformly good.
2	Dwarf Green (variety-NANA)	6.2	65.6	69.9	102	24.00	2,380	Fair (not Uniform)
3	Dwarf Red (a form of NANA)	6.8	60.8	65.2	90	17.25	2,922	Inferior
4	Dwarf Yellow (a form of NANA)	7.1	60.8	65.5	100	24.75	2,263	Inferior
5	King Coconut (variety)	7.4	60.8	65.6	100	31.25	1,792	Fair
6	Ran Thambili (a form of TYPICA)	7.5	63.3	68.5	19	9.25	1,150	Good
7	Gon Thambili (a form of TYPICA)	6.6	64.6	69.2	55	28.00	1,100	Good
8	Bodiri (a form of TYPICA)	7.2	64.6	69.6	20	2.25	4,978	Inferior
9	San Ramon (a form of TYPICA)	8.0	60.4	65.6	66	42.50	870	Good
10	Kamandala (Giant) (a form of TYPICA)	7.2	62.8	67.6	45	37.50	672	Good

(1 candy = 560 pounds)

Straits copra	65.0 to 66.5
Indonesia	65.8 to 67.5
Ceylon	67.0 to 69.5

It can be regarded as established, therefore, that there is a difference of from 2-3 per cent oil percentage in favour of Ceylon copra. Further, since Cooke found a difference of about 1 per cent between copras from Ceylon and Malayan nuts respectively, both dried under the same conditions, the difference cannot be altogether explained by the slower drying technique practised in Ceylon. The one per cent difference must, therefore, be due to some unexplained fundamental difference between the two countries, probably a resultant of the climatic environment.

Regarding fertilizer practice, the final criterion of yield in manurial and other experiments on the coconut palm is actually the quantity of oil obtained per acre. In practice, however, oil extraction would be an unwieldy procedure and the presentation of results on the basis of copra yields has to suffice. It is at the same time important to know whether manurial applications to coconut palms have any pronounced influence on the oil content of the copra produced.

To examine the above questions, records of copra yields per acre have been kept at the Coconut Research Institute and also moisture and oil determinations carried out on samples of copra from selected plots of the Soil Chemist's duplicated (3 x 3 x 3) factorial experiment on differential NPK manuring. The results have shown significant increases in the yield of copra (and thus oil) per acre over the years for different levels of potash manuring. For the complete results reference should be made to the Institute's published Annual Reports, but typical data are reproduced in Table X below.

Regarding the question of oil content there has been no indication whatever that the differential manurial treatments are reflected in the oil percentages of the copra samples. In fact it is surprising that the variation has been so small, the coefficient of variation recorded for the 96 samples examined being only 1.2 per cent.

Patel (5) quotes oil percentages of copra from 17 plots receiving different manurial treatments in a trial carried out in Madras, which he states appear to show that all treatments increased the oil content. His oil percentage figures which average 55.0 per cent were obtained by crushing the copra in a country oil mill. The recovery by this means would, of course, be very low and variable and the question of obtaining results sufficiently consistent for experimental purposes is reckoned an impossibility.

The experiments carried out on this subject at the Coconut Research Institute have only shown that during the second year after application, different fertilizer treatments to coconut palms did not affect the oil content of the copra. The possibility, however, cannot be

Table X

Soil Chemist's NPK Experiment - Yields of Copra

YEAR	Pounds Copra per Acre	
	$K_1 - K_0$	$K_2 - K_0$
1936	26	50
1937	47	80
1938	47	114 +
1939	28	120 +
1940	190 +	240 ++
1941	122	196 ++
1942	352 ++	196 ++
1943	300 ++	407 ++
1944	362 ++	546 ++
1945	329 ++	422 ++
1946	312 ++	447 ++
1947	382 ++	512 ++
1948	442 ++	582 ++
1949	401 ++	546 ++
1950	543 ++	711 ++
1951	664 ++	846 ++
1952	547 ++	799 ++
Total for 17 years	5,094	7,097
Mean/annum	294	418

\+ Significant at P .05

++ Significant at P .01

excluded that significant differences of oil content might begin to show after the palms have been differentially treated for a longer period. It is hoped to be able to check up on this point in the near future.

THE CEYLON COPRA KILN

In view of the fact that Ceylon copra is still recognised as the world's best commercial copra, it is felt that it would be appropriate to consider the drying stages and working procedure of the standard Ceylon Copra kiln.

The Ceylon Dryer which is fully described in Leaflet 15 published by the Coconut Research Institute (Ceylon) is a simple structure consisting essentially of a fire pit, a copra grill or platform, a corrugated iron roof fitted with a jack roof and covered working verandah. It has well known merits, being easily adaptable for use on large plantations as well as small village holdings. The drying procedure embodies adequate safeguards to minimise the production of inferior copra.

In drying practice, the halves of the split nuts are laid carefully face upwards on a concrete barbecue for one day's sun-drying. In the late afternoon they are collected and put on the platform of the kiln to a depth not exceeding 12 inches. After this the operator arranges the shells in the fire pit in parallel double rows, each shell being nested between contiguous shells. The drying process takes about five days, with about eight to nine firings. Details of the working programme during the five days drying have been carefully outlined in the leaflet.

It might be interesting at this stage to consider typical drying time curves obtained with the standard Ceylon dryer when following the operational schedule outlined in the leaflet. Table XI below gives typical moisture figures obtained during successive stages when the copra is dried in the form of (a) cut kernels and (b) half cups.

It has been shown already that the moisture content of the fresh coconut kernel may be reasonably expected to average 43.8%. It is generally reckoned that for optimum keeping qualities copra should be dried down to between 5 and 6 per cent moisture content. For the present purpose an average optimum of 5.5 % may be adopted. This would mean that for practical purposes the essential principle involved in copra manufacture is the reduction of the moisture content from the original 43.8 per cent to 5.5 %. In other words, 87.4 per cent of the total moisture in the original kernel would have to be removed. To accomplish this a host of drying systems have been evolved the world over in the different coconut growing countries. For a knowledge of these, reference could be made to two recent publications (6) and (7) which deal fairly exhaustively with the subject.

Though a discussion of the merits and demerits of the Ceylon Dryer itself is outside the scope of this paper, we could yet compare and contrast the salient features of the experimental results which have been presented in Table XI with some of the general findings and recommendations made in the FAO publication (6).

Table XI

(Moisture changes in copra during curing procedure in Ceylon Kiln)

1	2	3		4		5	
Stage	No. of hours since splitting	% Moisture		Tot. moisture lost since splitting		Tot. moisture loss as % of original	
		Cut Kernels	Half Nuts	Cut Kernels	Half Nuts	Cut Kernels	Half Nuts
On splitting	nil	43.5	43.3	nil	nil	nil	nil
After sundrying	10	38.0	37.8	5.5	5.5	12.6	12.7
" 1st firing	19	25.7	24.8	17.8	18.5	40.9	42.7
" 2nd firing	34	17.1	16.4	26.4	26.9	60.7	62.1
" 3rd firing	43	11.9	10.0	31.6	33.3	72.6	76.9
" 4th firing	58	10.1	8.0	33.4	35.3	76.8	81.5
" 5th firing	67	8.5	7.4	35.0	35.9	80.5	82.9
" 6th firing	82	8.4	6.5	35.1	36.8	80.7	85.0
" 7th firing	91	7.8	6.0	35.7	37.3	82.1	86.1
" 8th firing	106	6.6	5.4	36.9	37.9	84.8	87.5

On page 36 of this publication the statement is made that, "Eight hours of continuous sun-drying, with low atmospheric humidity and the sky free from cloud or mist, are sufficient to drive off half the moisture which has to be removed before the product is commercially dry, i.e. containing 6 to 7 per cent moisture." Obviously under climatic conditions prevailing in Ceylon (especially in the N.W.P.) this does not appear to obtain. It will be seen from the results that only about 12 per cent of the total moisture is lost during 10 hours of initial sundrying.

Regarding essential drying principles the following have been epitomised on page 40 of the publication under reference :-

(1) - The moisture content has to be reduced from 50-55 per cent to 35 per cent preferably within 24 hours.

(2) During the second 24 hours the moisture content should be reduced to about 20 per cent.

(3) In the next 24 hours the moisture content should be reduced to 5 or 6 per cent.

It will be seen at once from Table XI, column 3, that for the Ceylon Dryer the above requirements are more than fulfilled during the first 48 hours which may be regarded as the critical period of drying. Where the requirement is a reduction of the moisture content to 35 % within 24 hours the results show that after 19 hours the moisture has already dropped to 25-26 %. Again, when the requirement for 48 hours is a reduction to 20 %, the results show that in 43 hours the moisture is down to 10-12 %. During the next 24 hours, however, it will be seen that the rate of dryage is definitely slow in terms of the requirement. It would take at least 96 hours for the moisture to be reduced to 5-6 % in the Ceylon kiln as against the limit of 72 hours fixed. In the writer's opinion, from the point of view of copra quality the slower drying towards the end (in the Ceylon procedure) is a desirable feature. When the bulk of the moisture in the kernel has been expelled, overheating would definitely tend to caramelize the sugars with resultant discolouration, decomposition and also hardening of the meat.

It has been pointed out already that the principal virtue in the Ceylon kiln is its adaptability to both small and large scale processing. It can be said that there should be no difficulty in producing fairly uniform high grade copra with it, provided the standard operational procedure is rigidly adhered to. The question, however, of obtaining drying time curves approximating those illustrated on page 39 of the above publication (without loss of quality of the finished product) can be ruled out as a virtual impossibility. Curves such as the ones illustrated, where the moisture in the kernel drops from 50 to 5 per cent in eleven hours and even one hour can only be accomplished where artificial means are employed for the control of temperature and air speed. Further, these methods require special plant involving expensive fabrication and special conditions for operation, which consequently limit their application.

Relevant to the observations made on the Ceylon kiln, it is noteworthy that under precisely the same conditions it is definitely more advantageous and economical to dry copra in the form of half nuts instead of cut or broken pieces. Apart from the rate of dryage itself, it will be seen from the results that for the cut kernels, even after eight firings the moisture content is yet 6.6 per cent as against 5.4 % for

the cups. It has been found that as many as two extra firings may be required to reduce the moisture content further to 5.5 % when drying pieces. The fact that cut kernels deteriorate quicker than cups is a widely acknowledged fact. In transport too, broken pieces disentegrate further creating more and more "fines" and undesirable dust, which not only increase the acidity of the product but are also wasteful in handling. In general it can be stated that it is seldom that broken or cut kernels make the best copra.

GENERAL DISCUSSION

The available factual background information which has been reviewed above may be regarded as a reliable basis for a discussion of the different factors which may be expected to affect the quality of copra. As long as the mature coconut kernel always remains a fairly standard product there can be no reason why quality copra cannot be produced in all coconut growing countries. The actual problem, however, is that in the absence of definite monetary or price incentives with assurance of market stability no amount of propaganda or advice can induce producers to change their unsatisfactory methods of production.

(a) Factors that can be used for the reliable assessment of copra quality.

The factors which can be employed for the reliable assessment of copra quality may be classified as follows :-

(i) Evaluation of the commodity on its physical characteristics.

(ii) Evaluation on its analytical characteristics.

The old trade custom was to judge copra purely on its appearance. Any chemical analyses to reflect the quality of shipments had no accepted trade recognition and were employed in commercial transactions simply to emphasise or identify disputed points of quality that were or were not indicated by appearance. In recent years, however, copra analyses have been profitably used to some extent by crushers both as an advance guide before deliveries reached plants and for factory control purposes.

(i) Physical characteristics. It may be said that even at the present time the principal method by which copra traders estimate its value is based entirely on visual and tactile inspection. Visitors to the London Copra Association or the Ceylon Coconut Board Sales Room, whose sole function is arbitration between buyers and sellers, will not find any apparatus for chemical analysis, but merely long benches or racks on which the samples are exposed to the scrutiny of the judges.

Though this method may appear unreliable, it should be pointed out that it is based upon the experience of the valuer who appreciates the relationship between external characters and analytical characteristics. This relationship is based on the fact that good appearance is associated with careful preparation, low moisture and free fatty acid content, and good oil content. The method has the principal advantage of enabling large numbers of separate consignments to be marketed without the delay involved in chemical analysis.

In general, the physical properties that may be taken into consideration for the valuation of copra by appearance may be summarised as follows :-

A. PHYSICAL PROPERTIES	GOOD COPRA
1. Colour	The colour should be as white as possible.
2. Size & thickness	The copra should be thick and should not contain too great a proportion of small pieces.
3. Cleanliness	The copra should be free from extraneous matter.
4. Dryness	The copra should have a pearly lustre and biscuit hardness, and be free from moulds.
5. Condition	The copra should be round thick and smooth.
6. Smell	Characteristic and sweet.

B. ANALYTICAL CHARACTERISTICS.

The three principal analytical characters which can be used for assessing copra quality are :-

(a) Moisture content.

(b) Free fatty acid content.

(c) Oil content.

Moisture content. Of the three above-mentioned analytical characters, moisture content may be regarded as the most important factor which determines copra quality. Nothing else could in fact compensate for inadequate drying. Even in the physical method of inspection, scrutineers base their principal judgement on the basis of dryness which men of experience can accurately estimate by touch and feel.

It is very well known that the keeping qualities of copra depend upon its moisture content. Walker (8) has recommended that copra should be dried to 5 per cent and long storage avoided. Brill, Parker and Yates (9) give a figure of 6 per cent. Regarding the action of moulds, Lava (10) has reported that the "critical moulding moisture content" under a relative humidity of 81 per cent and about 28-30°C would be 8 per cent. The inference could, of course, be made that under conditions of higher humidity the moulds would appear at a lower moisture content. Passmore (11) records observations on copra stored in a London riverside warehouse from March to October, 1930, under an average relative humidity of 84.6 per cent. The copra remained mould free during this period and he has concluded that copra once dried to 6-7 per cent moisture content would not re-absorb sufficient moisture under ordinary conditions to support even a superficial mould growth.

The question of moisture re-absorption of copra under damp conditions is important and may be appropriately considered here. It can be said that if the temperature is assumed to be constant, there will be a point of equilibrium between the moisture of the copra and that in the atmosphere at every degree of relative humidity. Passmore (loc. cit.) regards this as about 5 per cent under English conditions. This means that copra drier than this will absorb moisture from the air until its content reaches 5 per cent, and copra water will dry out to 5 per cent. Cooke (loc. cit.) records that in Malaya the moisture content of good copra freely exposed to the air fluctuated between 3.5 and 8.0 per cent. In the low country of Ceylon, observations of a similar nature show a range of 5.2 to 7.9 per cent and the interesting point is that in sun-dried copra, which can be regarded as having been dried to equilibrium point, an average moisture content of 7.8 per cent has been found.

Taking into consideration all the recorded observations on the moisture content of copra it will be a reasonable recommendation that good copra should be dried down to a moisture content between 5 and 6 per cent in order to ensure maximum keeping qualities. Under humid conditions, however, where there is likelihood of moisture re-absorption there is little to gain by such stringent drying. A range of 6-7 per cent may be reckoned adequate under such conditions, when serious deterioration will not take place provided the copra is stored in well ventilated dry stores at an even temperature.

Free Fatty Acid. In the widest possible sense "rancidity" may be defined simply as a deterioration in odour and flavour which develops in fats on keeping. Generally, as the rancidity of a fat increases its free fatty acid percentage also rises. Though they do not run exactly parallel the f.f.a. content may be regarded as a measure of rancidity. The method is simple and in suitable cases sufficiently sensitive for detection of the progress of deterioration, even before "off" flavour or visible mould growth appears.

The figures given in the present study for the f.f.a. contents of the various grades of estate copra demonstrate that they are of positive comparative value. It will be seen that the respective acid values of the extracted oils do in fact correspond to different degrees of deterioration and rancidity. There can be no doubt that this is one of the valuable analytical factors which can be used to advantage in assessing the quality of copra. It should, however, be mentioned that if it is to be used in commercial transactions, the ultimate value of the system would depend entirely on the representative character of the samples taken and their preparation and analysis. Further, it is also important to adhere closely to proven methods that have been demonstrated to give results comparable with practical crushing. This is a crucial factor, because when there is lack of thoroughness and accuracy all else that follows in a transaction will fail in its purpose and not provide a trustworthy basis for settlement.

Oil content. On the basis of the preliminary survey, it may be safely concluded that the producer will have little or no control over the oil content of his copra. In fact, it has been shown that no regular variations in the oil content or composition have been detected with the time of harvesting or with the situation of the estate.

Since the actual oil percentage in a sample of copra as received will obviously depend on its moisture content, for comparative purposes oil percentages should always be calculated on the dry weight, i.e. as percentages of the moisture-free copra. This is valuable both from the point of view of making ready comparisons of relative oil contents and also in fixing standards for the oil content (without moisture complications). As the moisture content of commercial copra is so very variable the importance of expressing oil contents on a dry basis is demonstrated in Table XII below. The example taken for the illustration is a typical sample of estate copra containing 68.3 per cent of oil on a dry basis. A range of calculated figures is given showing how the oil content in this sample would change for graduated increases in the moisture from 0.5 to 10.0 %.

The figures eloquently show that for every rise of one per cent in the moisture the oil content would decrease by 0.683 %. The implications of this in commercial transactions should, therefore, be obvious, because on a weight basis the actual oil recovery would be contingent on the exact moisture content of the consignment.

Table XII

anges in the oil percentage of a sample of copra with increase of moisture

% Moisture		% Oil		% Decrease in oil
0.0	(dry basis)	68.300		
0.5		67.958		
1.0		67.617	-	0.683
1.5		67.276		
2.0		66.934	-	0.683
2.5		66.592		
3.0		66.251	-	0.683
3.5		65.909		
4.0		65.568	-	0.683
4.5		65.226		
5.0		64.885	-	0.683
5.5		64.544		
6.0		64.202	-	0.683
6.5		63.860		
7.0		63.519	-	0.683
7.5		63.177		
8.0		62.836	-	0.683
8.5		62.494		
9.0		62.153	-	0.683
9.5		61.811		
10.0		61.470	-	0.683

take an extreme example, suppose 2 lots of copra (100 pounds each con-
ining 68.3% oil on a dry basis) are bought at the same price ignoring
e moisture factor, if we assume that in fact one lot had 5% moisture and
e other 15 % moisture then the quantities of oil which could be recovered
om the two lots would be found on calculation to be :-

Lot	Quantity (lbs.)	Moisture (lbs.)	Dry matter (lbs.)	Oil (lbs.)
1	100	5	95	64.88
2	100	15	85	58.05
			Difference	6.83

nce the transaction is done purely on a weight basis, this would imply
at besides paying partly for water, the actual oil recovery from lot 2

would be 6.83 pounds less than from lot 1, or 153 pounds less for every ton of copra handled. The example further shows the importance of specifying the actual moisture content wherever the oil content is expressed on the sample as received (i.e. on a wet basis), so that the figures if required could be computed on a dry basis.

The oil content of the kernel can certainly be used as a factor for the assessment of copra quality, but, in view of the findings described in the preliminary survey, high percentages need not necessarily signify better quality. If this point is overlooked the position may arise where the inferior grades will pass the standard, but not the superior ones. This point is worthy of note.

(b) Quality standards that can be reasonably enforced in commercial transactions.

As already mentioned, copra is generally bought and sold not on analysis of sample, but on a standard based on appearance. Though this may be adequate for the very superior grades, a consideration of both physical and analytical factors is the only reliable basis for the assessment of quality in commercial transactions. Even when this is done, the subject can yet be difficult because it interlocks with all the problems associated with grading and sampling.

Though separate standards may have been laid down for each producing country, there is no accepted general standard. This, of course, is considered a virtual impossibility because copra is such a highly variable product. The formulation and enforcement of strict standards (embracing both physical and analytical characters) would only become a practical proposition when definite grades have been recognised and established.

(c) Need for a grading system with grade standards.

Whether or not international standards are agreed upon and introduced, as a first step it would appear that a unified system of copra grading for the various exporting countries would be a desirable feature. It is felt that if the system is to work with any degree of efficiency, rigid standards would have to be coupled with adequate incentives for the production of the higher grades. So long as the grading systems and standards in the various exporting countries are not comparable, the problem of evolving acceptable international [illegible] would be made more difficult.

In regard to legislation, it has been the ex[illegible] some countries that in the absence of adequate price premia [illegible] attempts to improve the quality of exported copra by legisl[illegible] been very effective.

The system of grading copra according to the country of origin and to description of grade cannot be regarded as an altogether satisfactory method, as it hinges on the difficult problem of the producer and exporter working in close collaboration. The terms used in international trade to arbitrarily define quality standards are given in publication (6) which are reproduced in Tables XIII and XIV.

Table XIII

Standard Copra Grades in Order of Market Value

F. m. g. w. s.
F. m. s.
F. m. s. Standard.
F. m. s. Trade.
F. m.
F. m. Hot air dried.
F. m. mixed.
F. m. kiln dried, and so on.

F. m. g. w. s. - Fair, merchantable, good, white, sundried.

F. m. s. - Fair, merchantable, sun-dried.

F. m. - Fair, merchantable (not necessarily sundried, usually kiln-dried.).

F. m. mixed - Fair, merchantable, mixed (i.e. sundried and kiln dried proportionately, but not necessarily 50/50).

Though the grading and testing of copra on the basis of predetermined qualifications and standards would not necessarily ensure its arrival at the port of discharge in the same condition, yet the buyer could always expect a high degree of uniformity within the grades. It can only be repeated for emphasis that the evolution of a unified and efficient grading/sorting system on the basis of clearly defined standards (to be applied within all exporting countries) must be regarded as essential if standardization of copra grades in the larger sphere of international trade is to be accomplished in the future.

Table XIV

Definition of several grades of copra (not internationally accepted)

Description	Definition
Perfect, super grade	Smooth, hard clean, snow white, free from all extraneous and defective matter.
High grade	Smooth, hard, clean, pale grey to dull white, with no discoloured or bad pieces.
F.m.s., made on improved kilns or on estates	Commercially white, dry copra, containing between 5 and 50 % of somewhat smoky or slightly discoloured pieces.
Mixed, ordinary smoke dried	Underdried copra of uncertain and irregular quality.
F. m.	A blend of dry mixed and dry low grade copra with no hard white pieces but much soft and rubbery copra.
Low grade	Underdried copra consisting entirely of burnt, discoloured, over-smoked, putria, insect ridden, rubbery and/or soft glutinous pieces with much torn and broken material.

(d) Prerequisite conditions that would ensure production of high quality copra.

In broad outline, the conditions that should be observed to ensure the production of high quality copra could be summarized as follows :

(i) Careful harvesting, avoiding under-ripe (immature) and over-ripe (germinated) coconuts.

(ii) Seasoning. Whenever picked, green, ripe nuts are used, they should be seasoned on the field for a period of 3-4 weeks.

(iii) Careful pretreatment. During husking and splitting operations, in particular where contamination with extraneous matter could occur, or sliming overnight of cracked nuts.

(iv) Careful processing in efficient kilns.

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For full details referrence could be made to Leaflet 25 published by the Coconut Research Institute on this subject.

(e) Copra Sampling.

In introducing my subject I emphasised the importance of careful and representative sampling of a commodity like copra and pointed out that unless this is ensured all other analytical operations would be futile.

In view of the multifarious drying treatments and the numerous concomitant factors of processing, copra can be a highly variable product of very heterogeneous quality, so much so that in a sample representing hundreds of tons it may be difficult to find even two pieces exactly alike. Wherever damage is most pronounced, free fatty acids and colour of the oil would tend to be highest. Further, broken pieces and "fines" which are highest in free fatty acids and lowest in oil content would have to be uniformly incorporated in the sample to be analysed to ensure consistent and reliable results. Naturally, in commercial methods any sampling technique employed would have to overcome these problems if dependable results are to be obtained. Since the National Institute of Oilseed Producers (N.I.O.P.) has agreed to make available to this committee its method of commercial sampling, it is not proposed to deal with this subject here. It should, however, be mentioned that commercial samples are taken by professional samplers who by long experience acquire skill in the art.

Sampling copra in the laboratory is a comparatively simple process and a satisfactory method giving concordant results on duplicates has been worked out and applied at the Coconut Research Institute.

CONCLUSION

The principal use of commercial copra is the manufacture of oil. It is a safe assumption that the greatest portion of the commercial supply of coconut oil will continue to be made from copra by conventional methods for many years to come. Since consumers of coconut oil require an odourless oil of light colour and of low free fatty acid content the importance of producing quality copra should be appreciated by copra producers, marketing authorities and exporters.

Except in such rare instances as damage at sea, almost every case of inferior quality can be traced back to causes in the country of origin. Since proper handling, drying, storage and shipment of copra have an important bearing on the final quality of the product, producers and consumers should appreciate each other's problems and make concerted efforts towards a general improvement of quality, which would certainly pay dividends to the industry.